

2022 Climate Review for Puerto Rico and the U.S. Virgin Islands

Synopsis:

The year 2022 was one of extremes: from droughts in January to a hurricane in September. The year was carrying rainfall deficits from 2021, and nearly 80% of the territories were under some drought classification. In the middle of the dry season, a potent polar trough dug into the Dominican Republic, favoring a rainfall event with astonishing amounts collected over sections of northeastern Puerto Rico. As a result of this event, February ended as the wettest February on record for San Juan. The drought pattern resumed afterward, and once again most of the islands were plagued by the lack of rains. In May, the Intertropical Convergence Zone lifted into the eastern Caribbean, and the atmosphere became conducive for severe weather, triggering a high-end EF-01 tornado in Arecibo. This tornado was the strongest ever recorded over the forecast area. At the beginning of the hurricane season, and well into the summer and even the fall months, several Saharan dusts were detected, limiting visibility and deteriorating the air quality. Temperatures were above normal during this period, and 29 heat advisories and one Extreme Heat Warning were issued. The Atlantic Ocean was unusually dormant during August, worsening drought classifications across Puerto Rico and the Virgin Islands. However, category one Hurricane Fiona moved across during September, dumping over 25 inches of rain and causing catastrophic flooding over sections of southern Puerto Rico. Obviously, the islands were abruptly freed of any flood classifications for the time being. Other two significant rainfall events were registered by the end of October and early November, with significant hydrological impacts. At the end of the year, calmer weather was observed and December ended drier than normal across all the main climatological sites, with abnormally dry conditions making a comeback for sections of Puerto Rico and the U.S. Virgin Islands.

Summary:

Just as what happened during most of 2021, the first month of 2022 ended drier than normal. The drought conditions worsened across all the islands throughout the month (Fig. 8). Abnormally dry conditions covered most of Puerto Rico, while moderate to even severe drought was also present in some sections. However, on the last day of the month, the combination of an area of low level convergence, increased instability and a southwest flow in the mid to upper levels, resulted in a significant rainfall event mainly for Guaynabo and San Juan. Doppler radar estimates were around 3 to 5 inches, with isolated higher amounts. These rains resulted in several reports of flooding, mudslides, and trees down. The unusual instability continued into early February, when a frontal boundary and the associated deep moisture moved over Puerto Rico and the U.S. Virgin Islands on Friday, February 4th. This feature enhanced the low-level moisture convergence over northeast Puerto Rico including the San Juan Metro area producing rainfall accumulations of 1-3 inches in some spots. Additionally, showers that developed early in the week led to locally high rainfall totals, in excess of 4 inches in a matter of hours in some areas,

including San Juan, Carolina, Vega Alta and Vega Baja. Therefore saturated soils were observed in many areas, especially along the north coast of Puerto Rico and portions of the San Juan metro area. These were the antecedent conditions ahead of the more significant event that came during the weekend.

On Saturday and Sunday, a strong upper trough slowly moved southward over Puerto Rico providing a very unstable environment across the region. This upper-level feature combined with the remnants of the front lingering over the region supports the development of another round of heavy rainfall. The convergent flow at low levels caused the higher moisture band to remain over northeastern Puerto Rico leading to better precipitation efficiency that resulted in prolonged periods of heavy rainfall especially in the western half of the metro area mostly on Saturday where accumulations across these areas ranged between 3-6 inches with a maximum of 10 inches in some areas (Fig. 1). On Sunday, several rounds of heavy rainfall over the same areas only aggravated the flood problems. Conditions gradually improved on Monday as moisture and instability decreased considerably. As a result of these rains, San Juan (SJU) ended as the wettest February on record.

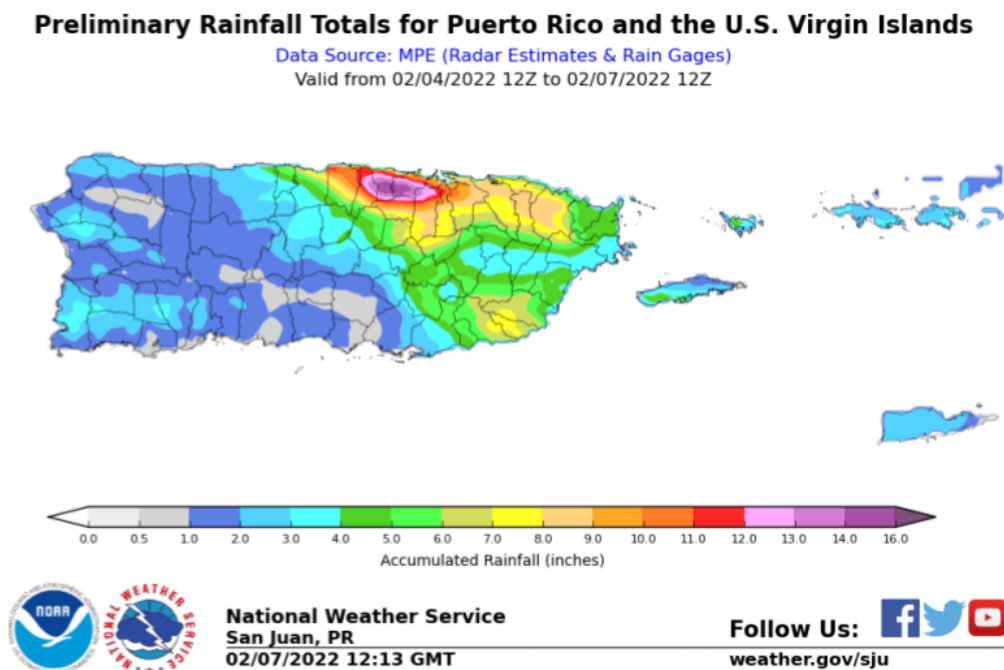


Fig 1. Rainfall estimates for the main rainfall event in February, where over 12 inches of rain were registered over north-central Puerto Rico.

During the heart of the dry season, persistent showers were observed across the islands. There was no significant weather event during March, but continuous patches of moisture made this

month near to above normal for many sections of Puerto Rico, and also for the northern U.S. Virgin Islands. Saint Croix did not run with the same luck, and drought conditions continued to worsen. Even though April is climatologically a transition month between the dry and wet season, rainfall events were scarce, and most of the territory ended drier than normal.

The dry spell stretched into May, although with one very particular exception. On May 2nd a line of showers and thunderstorms affected a few north-coastal municipalities of Puerto Rico, leaving between 2 and 4 inches of rain in some areas, yet the San Juan International Airport only observed 0.33 inches of rain during that event. The rest of the month, we observed either very little rain or a few locally induced showers and thunderstorms. Though some isolated thunderstorms were near severe, causing intense lightning and hail, the rainfall totals were overall not impressive. The presence of Saharan dust causing hazy skies and the occasional small wildfire across several spots over Puerto Rico were common this month. Most of Puerto Rico experienced a rainfall deficit of 4 to 8 inches, while St. Croix made it as the 2nd driest May on record. Temperatures soared into the 90s for the first time this month (Fig. 2), and in combination with high humidity content, the first couple of heat advisories of the year were issued.

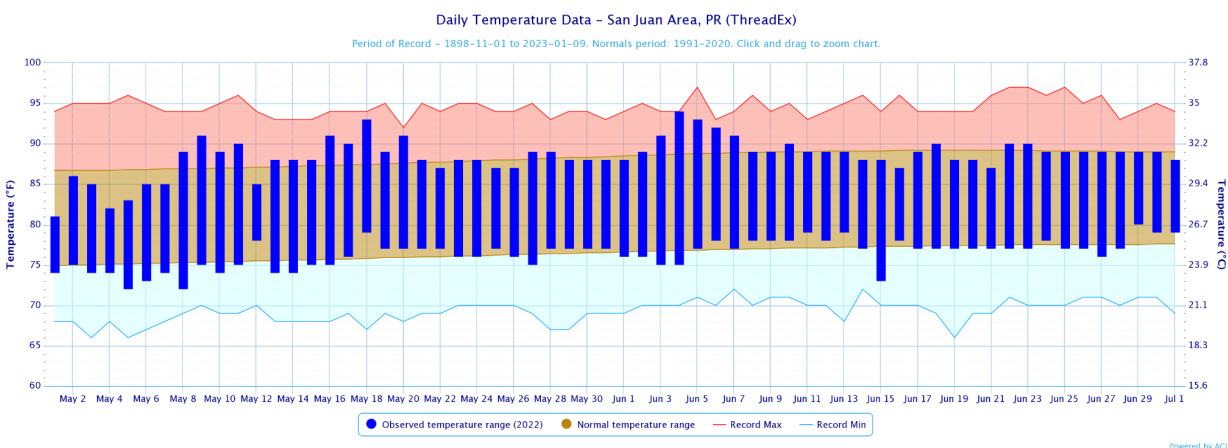


Fig 2. Temperatures reached the 90s in May for the first time in 2022, and heat advisories were issued.

The most significant event of the month was undoubtedly a high-end EF-1 tornado reported on the first day of the month (Fig. 3). Strong to severe thunderstorms over north-central Puerto Rico merged and produced a tornado between Urbanization Victor Rojas 2 and Highway PR-2 in Arecibo around 310 PM AST. Observers at the Avenida Industrial and Urb. Victor Rojas 2 reported a tornado affecting these areas for about 5 minutes. Social media videos, as well as observers, reported that the tornado was moving towards the east-southeast over the warehouses along the Industrial Park in Arecibo. Damage was observed from Avenida Industrial southeastward into Road PR-129. The tornado caused significant damage to the warehouse

infrastructure as well as knocked down trees, traffic signs, and power lines near a hospital parking lot, dissipating just before reaching Road PR-129.

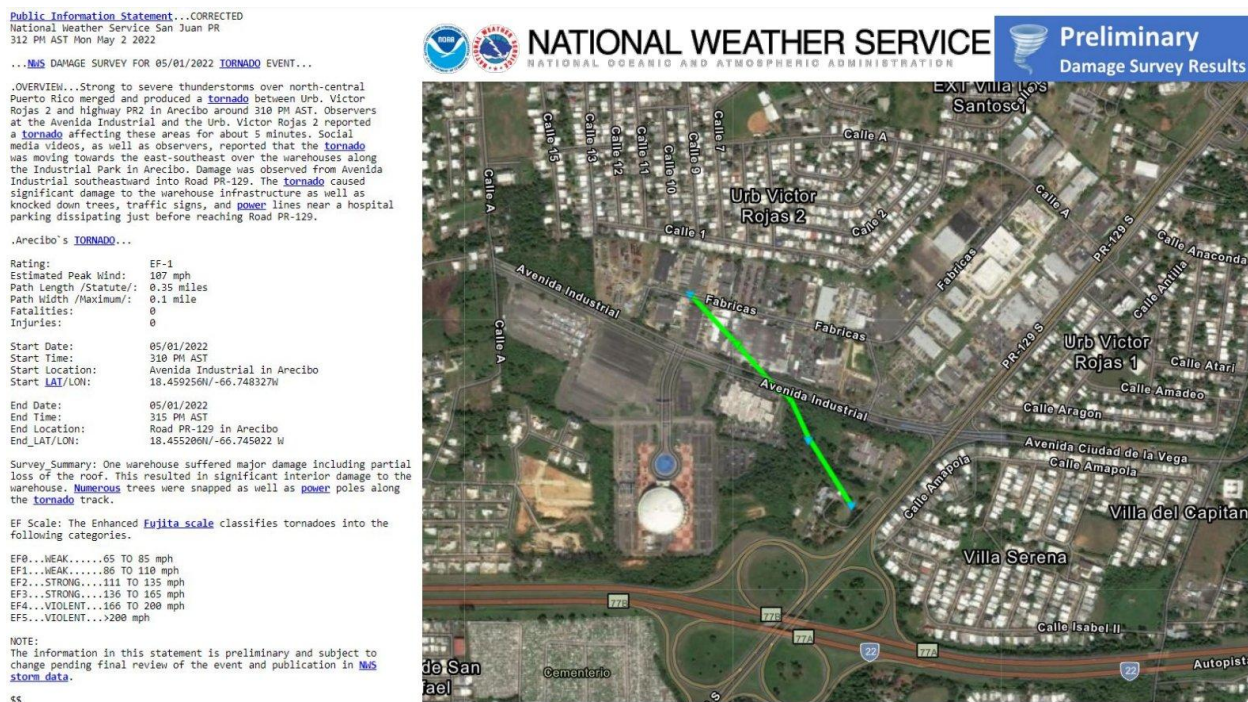


Fig 3. Public Information Statement and tornado trajectory in Arecibo, PR.

By June, the mid-drought and the beginning of the meteorological summer was, once again, characterized by below normal rains (Fig. 8). Rainfall deficits ranged in the order of 5 to 8 inches for the northeast, while it was 1 to 4 inches for the other areas. All of the climatological sites ended drier than normal. Above normal temperatures persisted during this period as well, with 4 daily maximum temperature records being established in Saint Croix. The most significant event this month was Potential Tropical Cyclone Two, that moved well south of the islands, but it did bring gusty winds.

Some changes in the pattern were finally observed across the territories during July, with many areas receiving above normal rainfall. Rainfall estimates from the Doppler radar were in the order of 10 to 20 inches along east, west, Vieques and sections of the San Juan metro area in Puerto Rico. In the central interior, extreme northeast, and south-central plains, 2 to 5 inches were observed. For the U.S. Virgin Islands and Culebra, 2 to 5 inches were collected. The main rain event was associated with a strong tropical wave that crossed the area on the 3rd of July. This wave brought strong shower activity for eastern Puerto Rico, as well as for the U.S. Virgin Islands. Several flood advisories and warnings were issued. The wave also brought strong gusty winds across the area. During the rest of the month, several upper level troughs and tropical

waves moved through, but not as significant as the first wave. A few low to moderate Saharan dust events also occurred, with hazy skies frequently observed.

August was characterized by another hot spell, with nine heat advisories issued. All of the main climatological sites ended warmer than normal, with Saint Croix ending almost two degrees above the 30-year average (3rd warmest August on record). There were six daily maximum temperature records established in Saint Croix. Many areas received above normal rainfall amounts this month, mostly due to the combination of local effects and available moisture. Therefore, the areas with higher amounts were in the interior and west, around the San Juan metro area and the extreme east. As a result of these rains, improvements were observed across the interior and eastern Puerto Rico due to the continuous rainfall. Across the U.S. Virgin Islands, despite the record rainfall observed in Saint Thomas, the rest of the island remained drier than normal and conditions did not improve. Moderate drought persisted for Saint Thomas and Saint Croix, while an Extreme Drought continued for Saint John.

Hurricane Fiona brought catastrophic flooding for several sections of Puerto Rico in September. Due to the significant surplus of rain, the drought was erased across all of Puerto Rico and for most of the U.S. Virgin Islands (Fig. 8). Additionally, distant Hurricane Earl also aided in the development of significant rains, mainly affecting eastern Puerto Rico as well as the United States Virgin Islands. Unfortunately, during this event, two people died when lightning from a thunderstorm reached them in a jetski on a beach in Salinas.

With the 2 AM AST Tropical Weather Outlook on September 12, 2022, a tropical wave located more than 1000 miles east of the Windward Islands was identified by the National Hurricane Center as having a 20% chance of development over the next five days. At the time, it had a large, disorganized area of showers associated with it, and was forecast to move westward to west-northwestward. Prior to development, the Hazardous Weather Outlook (HWO) included a mention of “an elevated risk of flooding” for the area associated with a strong tropical wave, which was forecast at the time to arrive on Friday; this mention first appeared in the HWO issued at 10:52 PM on Sunday, September 11.

Tropical Depression 7, which eventually became Hurricane Fiona, formed on Wednesday, September 14, 2022, with the first advisory issued at 11 AM AST; at the time, it was 805 miles east of the Leeward Islands. The storm was heavily sheared, with the bulk of the convection occurring to the east of the center. Even so, it continued to strengthen, becoming a tropical storm less than 12 hours later.

The initial Flood Watch was issued by the Forecast Office for all Puerto Rico and the US Virgin Islands on Thursday, September 15th, 2022 at 12:50 PM AST. The issuance of the Flood Watch came before the issuance of any tropical product due to the high confidence in a rainfall event, regardless of the intensity or trajectory associated with Fiona. It was highlighted that the areas most likely to receive the highest rainfall accumulations were portions of eastern Puerto Rico.

Flooding began to affect portions of the CWA early Sunday, September 18th with the first Flash Flood Warning issued at 8:25 AM AST for Saint Croix. Flooding became widespread across the eastern half of Puerto Rico by midday and across the western half of the island during the afternoon hours. Based on preliminary information from the US Geological Survey Streamgauge Network, 50 out of 108 river gauges rose above the USGS-NWS flood stage. Most river gauges along Río Grande de Manatí, Río Cibuco, Río Grande de La Plata, Río Grande de Arecibo, Río Grande de Loíza, and Río Guanajibo rose above moderate or major flood stage. Across southern and southeastern portions of the island, significant to catastrophic flooding was observed due to sharp rises along rivers combined with storm surge/coastal flooding. As a matter of fact, thousands of families were rescued in Salinas where a Flash Flood Warning with a catastrophic threat tag was issued on Sunday night. About 50 Flash Flood Warnings and about 30 Flood Warnings were issued between Sunday, September 18th and early Tuesday, September 20th. The flooding rains associated with Fiona significantly improved the observed drought conditions across the local islands with “Moderate Drought”(D1) and “Severe Drought” (D2) classification being removed across Puerto Rico (Fig. 8). Several improvements were observed across the U.S. Virgin Islands as well (Fig. 4).

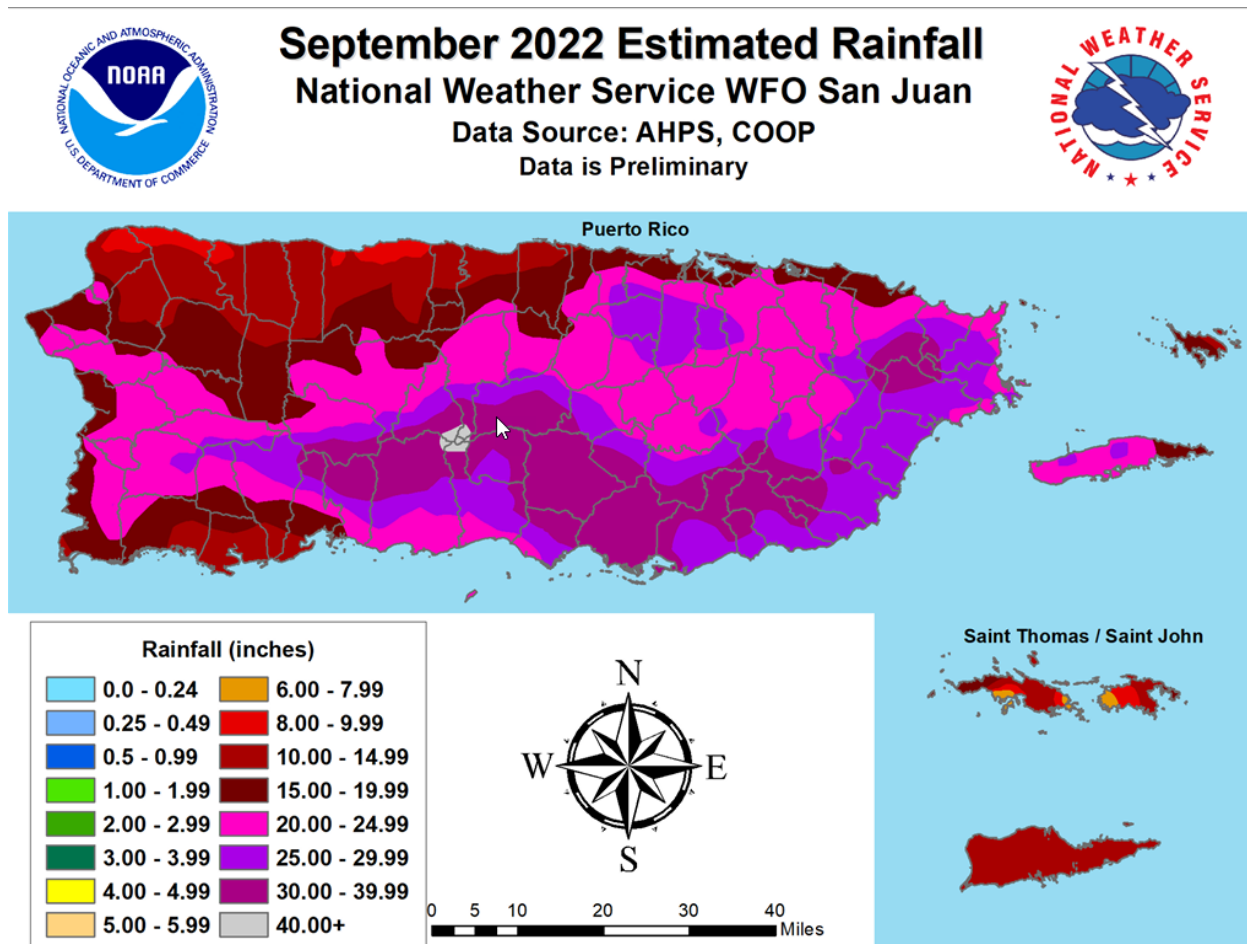


Fig 4. Total rainfall amounts during the month of September. Most of the rain was attributed to Hurricane Fiona, but distant Hurricane Earl earlier in the month also contributed to the rain totals.

Aside from the rains, very warm temperatures persisted during this month (Fig. 5), and another nine heat advisories were issued this month. Additionally, the first ever Extreme Heat Warning was issued this month as well. This heat event occurred just after Hurricane Fiona, when most of the population was dealing with the loss of power and water services.

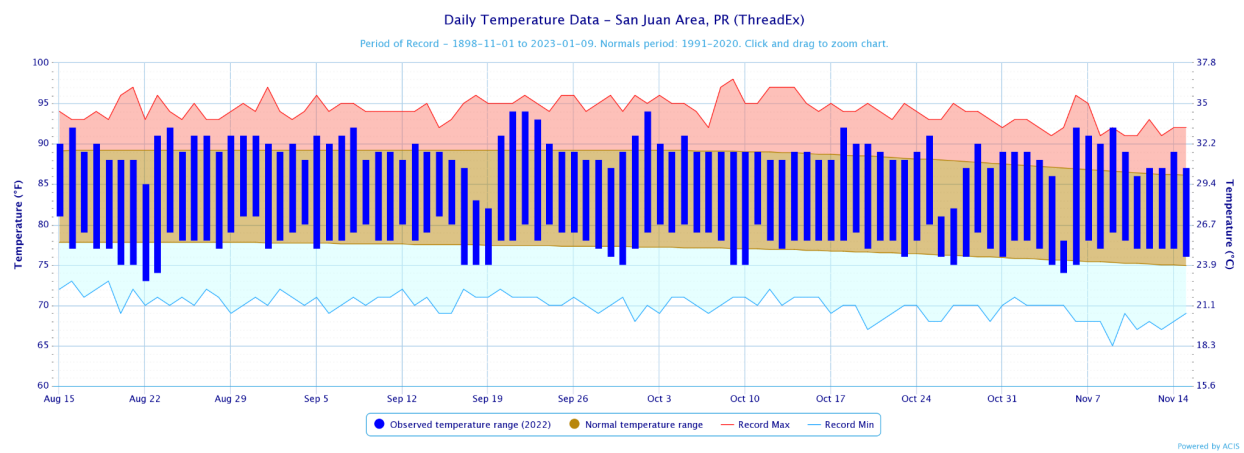


Fig 5. Another warm spell persisted in August, September and October, and 20 heat advisories and one Extreme Heat Warning was issued during this period.

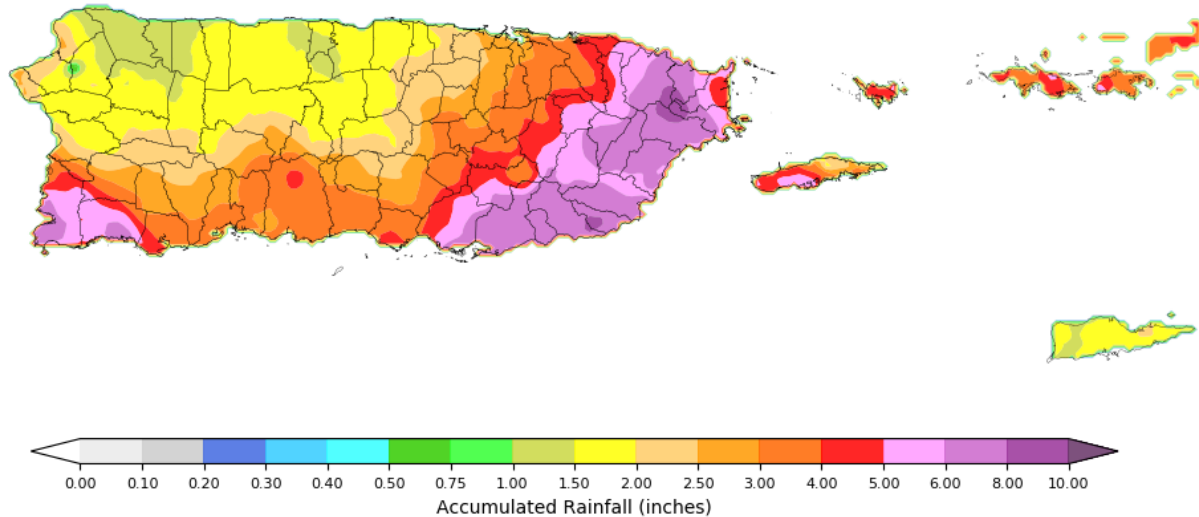
To add insult to injury, two other significant weather events were observed in October and November, almost back to back. Soils were already saturated due to previous rains from Fiona, and many rivers went out of their banks, while significant flooding events and mudslides were reported in each of these events.

Late in October, a deep upper trough with the axis oriented south to north from Hispaniola to the eastern US sustained a large area of enhanced upper divergence over Puerto Rico and U.S. Virgin Islands. An induced trough and its associated moisture interacted with a tropical wave moving westward across the eastern Caribbean. The interaction of the tropical wave and the aforementioned upper level trough created a favorable environment for organized deep convection. As a result, widespread rains were observed across Puerto Rico and the U.S. Virgin Islands. Twenty-four hours prior to the event a Flash Flood Watch was issued for the islands. The event lasted about 60 hours, with the highest rainfall amounts registered over east, southeast and southwest Puerto Rico, where 5 to 10 inches were collected (Fig. 6). For the U.S. Virgin Islands, Vieques and Culebra, 1 to 4 inches of rain were observed. The continuous rains resulted in multiple mudslides and flooding reports, as well as a few major rivers out of their banks.

Preliminary Rainfall Totals for Puerto Rico and the U.S. Virgin Islands

Data Source: MPE (Radar Estimates & Rain Gages)

Valid from 10/26/2022 00Z to 10/28/2022 12Z



National Weather Service
San Juan, PR
10/28/2022 10:27 GMT

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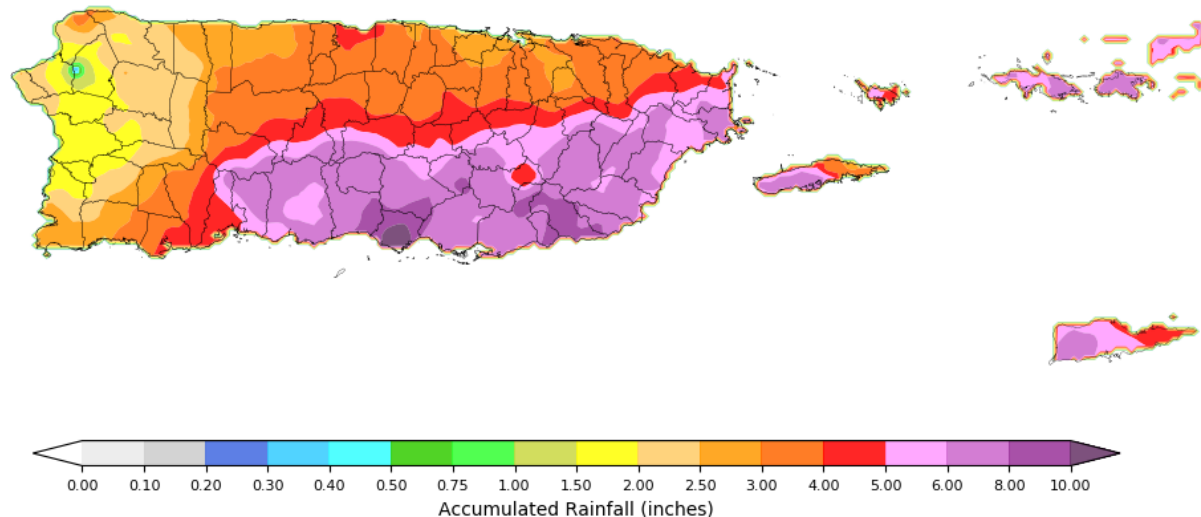
Fig. 6. The first of two almost back-to-back rain events was observed by late October. Some areas received 5 to 10 inches of accumulation.

Early in November, a deep upper level low produced organized convection across the islands, especially on Saturday. Widespread rains were observed across Puerto Rico and the U.S. Virgin Islands. Twenty-four hours ahead of the event a Flash Flood Watch was issued for the islands. The event lasted about 48 hours, but persistent heavy rainfall lasted about 18-24 hours with the highest rainfall amounts registered over east and southeast Puerto Rico and U.S. Virgin Islands, Vieques and Culebra, where 4 to 8 inches occurred during the event. For western and northern Puerto Rico, 1 to 3 inches of rain were observed (Fig. 7). Persistent rains resulted in multiple mudslides and flooding reports, as well as a few major rivers out of their banks.

Preliminary Rainfall Totals for Puerto Rico and the U.S. Virgin Islands

Data Source: MPE (Radar Estimates & Rain Gages)

Valid from 11/04/2022 18Z to 11/08/2022 12Z



National Weather Service
San Juan, PR
11/08/2022 11:41 GMT

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Fig 7. The last significant rain event of the year was observed early in November, virtually affecting the same areas previously affected by the October event and Hurricane Fiona.

Aside from the rains, October and November were also warm months, with above normal temperatures registered at the main climatological sites. San Juan made it to the top 10 warmest October in history, while the U.S. Virgin Island sites made it to the top 10 in October and November.

After all those rain events, below normal rains returned to close the year 2022. Below normal rains were observed for almost all the area in both Puerto Rico and the U.S. Virgin Islands (Fig. 13 & 14). These lack of rains brought back Abnormally Dry conditions for sections of the southern and northern plains of Puerto Rico, as well as for all of the U.S. Virgin Islands.

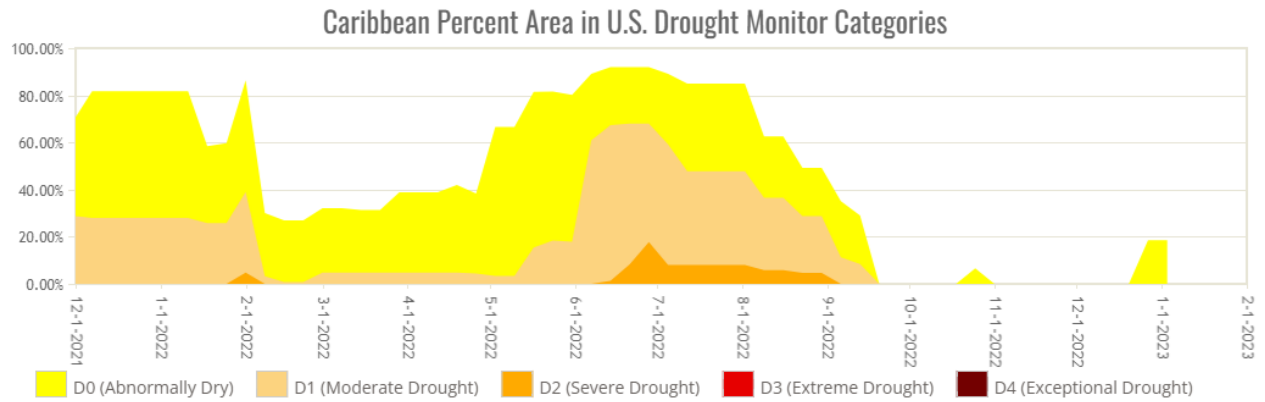


Fig 8. Time series of drought conditions across the islands. The drought was present most of the year, with the worst classifications from June to August. Significant improvement was observed after Hurricane Fiona.

Looking Ahead

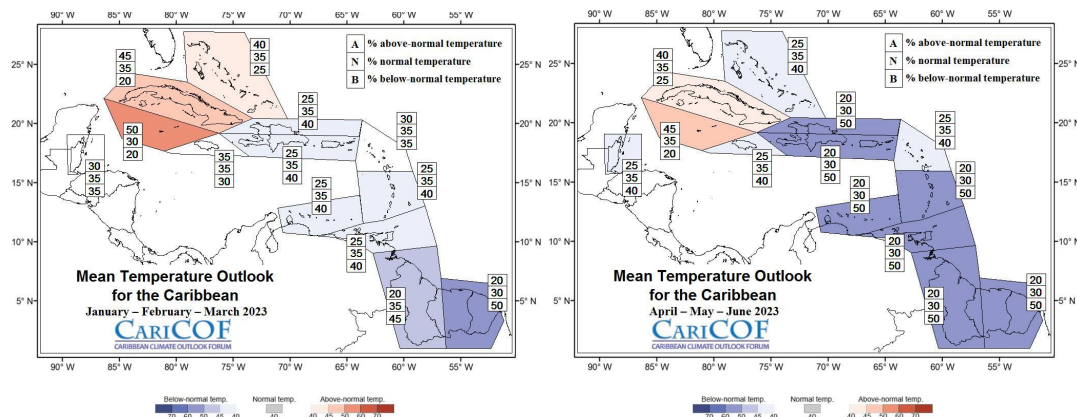


Fig 9 and 10. CariCOF mean temperature forecast for Jan-Feb-Mar and Apr-May-Jun

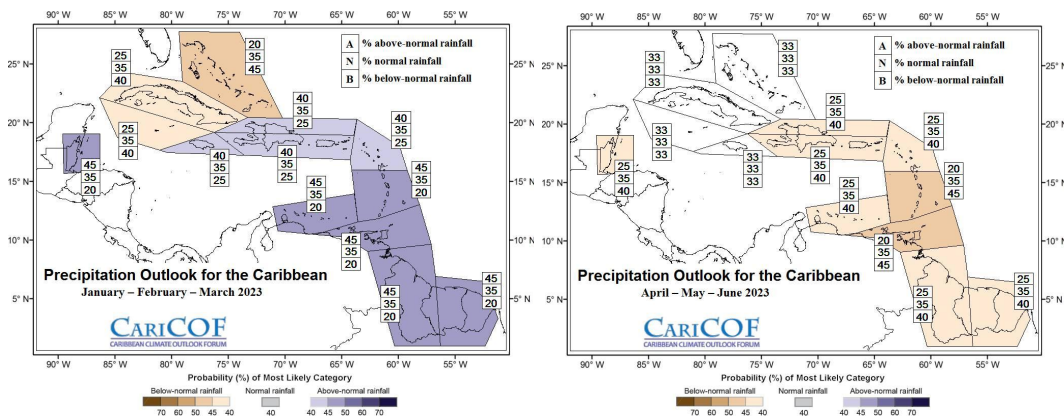


Fig 11 and 12. CariCOF precipitation forecast for Jan-Feb-Mar and Apr-May-Jun

A transition from La Niña to ENSO-neutral is expected at any time from February to April 2023. Below average Sea Surface Temperatures (SSTs) weakened considerably during December 2022. Most models show a transition to ENSO-neutral during the Northern Hemisphere winter 2022-23. When there are ENSO-neutral conditions, there is no significant impact or contribution to the forecast, but it does add uncertainty. Temperatures are expected to remain below normal through early summer across the northeastern Caribbean (Fig. 9 & 10). The first few months of 2023 are expected to be wetter than normal, but drier than normal conditions are expected to return in the April through June period (Fig. 11 & 12).

More Info: <http://rcc.cimh.edu.bb/long-range-forecasts/caricof-climate-outlooks/>

2022 Monthly & Seasonal Highlights for Primary Climatological Data Sites

	Dec (2021)	Jan	Feb	Season
JSJ	10 th warmest 79.8°F 3.72"	77.7°F 2.73"	76.9°F Wettest 11.69"	78.1°F 7 th wettest 20.09"
IST	10 th warmest 80.4°F 7 th driest 1.41"	78.3°F 1.34"	77.6°F 5 th wettest 3.29"	78.8°F 6.04"
ISX	3 rd warmest 81.0°F 6 th driest 1.18"	78.6°F 2.22"	78.1°F Wettest 4.86"	9 th warmest 79.2°F 8.26"

Table 4. Winter 2021-22

	Mar	Apr	May	Season
JSJ	77.9°F 3.44"	79.0°F 2.92"	81.5 5 th driest 1.04"	79.5°F 7.45"
IST	78.4°F 9 th wettest 3.05"	6 th coolest 78.8°F 2.43"	81.0°F 7 th driest 0.88"	79.4°F 6.36"
ISX	78.9°F 1.18"	80.2°F 8 th driest 0.57"	9 th warmest 82.5°F 2 nd driest 0.35"	80.5°F Driest 2.10"

Table 5. Spring 2022

	Jun	Jul	Aug	Season
JSJ	83.3°F 1.64"	82.4°F 8.13"	84.1°F 9.73"	83.3°F 19.50"
IST	83.0°F 6 th driest 0.34"	83.7°F 2.19"	9 th warmest 85.3°F 5.85"	84.0°F 8.38"
ISX	83.9°F 10 th driest 0.73"	83.8°F 4.15"	3 rd warmest 85.2°F 2.15"	84.3°F 7.03"

Table 6. Summer 2022

	Sep	Oct	Nov	Season
JSJ	83.6°F 6 th wettest 13.57"	83.3°F 6.61"	5 th warmest 82.0°F 6.43"	10 th warmest 83.0°F 10 th wettest 26.58"
IST	83.9°F 7.41"	10 th warmest 83.5°F 6.51"	10 th warmest 81.9°F 6.80"	83.1°F 21.02"
ISX	5 th warmest 84.3°F 2 nd wettest 11.80"	6 th warmest 83.4°F 2.80"	9 th warmest 81.7°F 6.47"	83.1°F 9 th wettest 21.07"

Table 7. Fall 2022

	Dec (2022)	2022 Year-End
JSJ	79.4°F 3.72"	80.9°F 71.67"
IST	79.9°F 3 rd driest 0.82"	81.3°F 41.21"
ISX	79.0°F 2 nd driest 0.60"	6 th warmest* 81.6°F 37.88"

Table 8. December 2022 and Year-End 2022 Highlights (6th warmest year, allowing only 5 days of missing data per year)

Additional Highlights Based on COOP Data

Variable	Value	Date	Station
Highest Max	97 °F	8/10/22	Ponce 4E
Lowest Max	80 °F	10/28/2022	Coloso
Highest Min	84 °F 82 °F	9/2/2022 7/31/22	Christiansted Fort Aguirre
Lowest Min	50 °F	1/30/2022 12/13/2022	Adjuntas AES Toro Negro
Wettest Day (24 hrs)	15.11"	9/19/22 (Fiona)	Juncos
Wettest 3-day period	22.10"	9/19/22 (Fiona)	Toro Negro
Wettest month	34.86"	September	Toro Negro

Table 9. Extreme values registered across the COOP network in Puerto Rico and the U.S. Virgin Islands. Data are preliminary and have not undergone final quality control by the National Centers for Environmental Information / NCEI/. Therefore, these data are subject to revision.

Maps with radar estimated rainfall and rainfall deficits

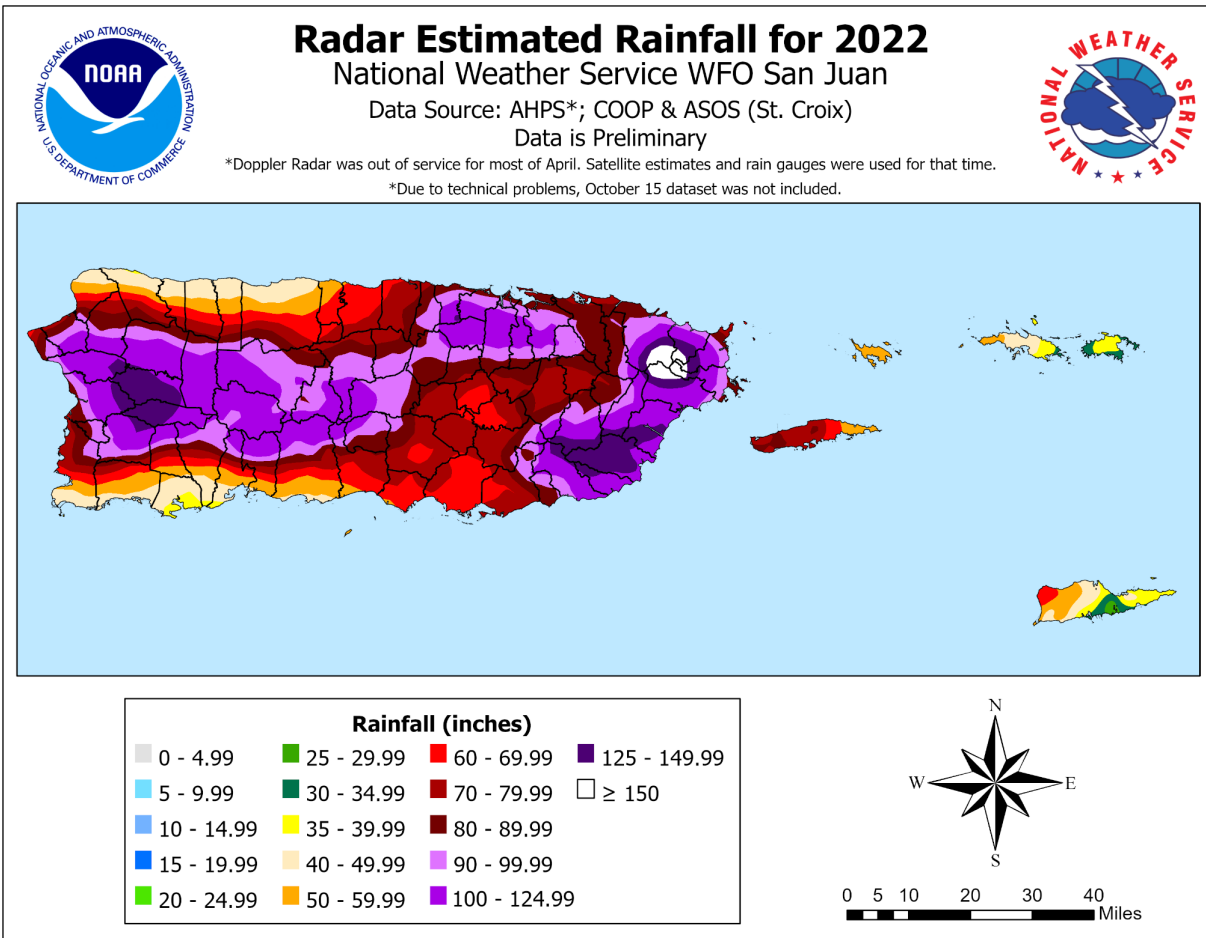


Fig. 13. Radar estimated Rainfall for Puerto Rico and the U.S. Virgin Islands for 2022. Over 150 inches of rainfall were observed around El Yunque, and more than 100 inches were registered for the southeast, the San Juan metro area, the western interior and west of Puerto Rico. For the U.S. Virgin Islands, some areas received as little as 25 to 30 inches, with others collecting as much as 60 to 70 inches.

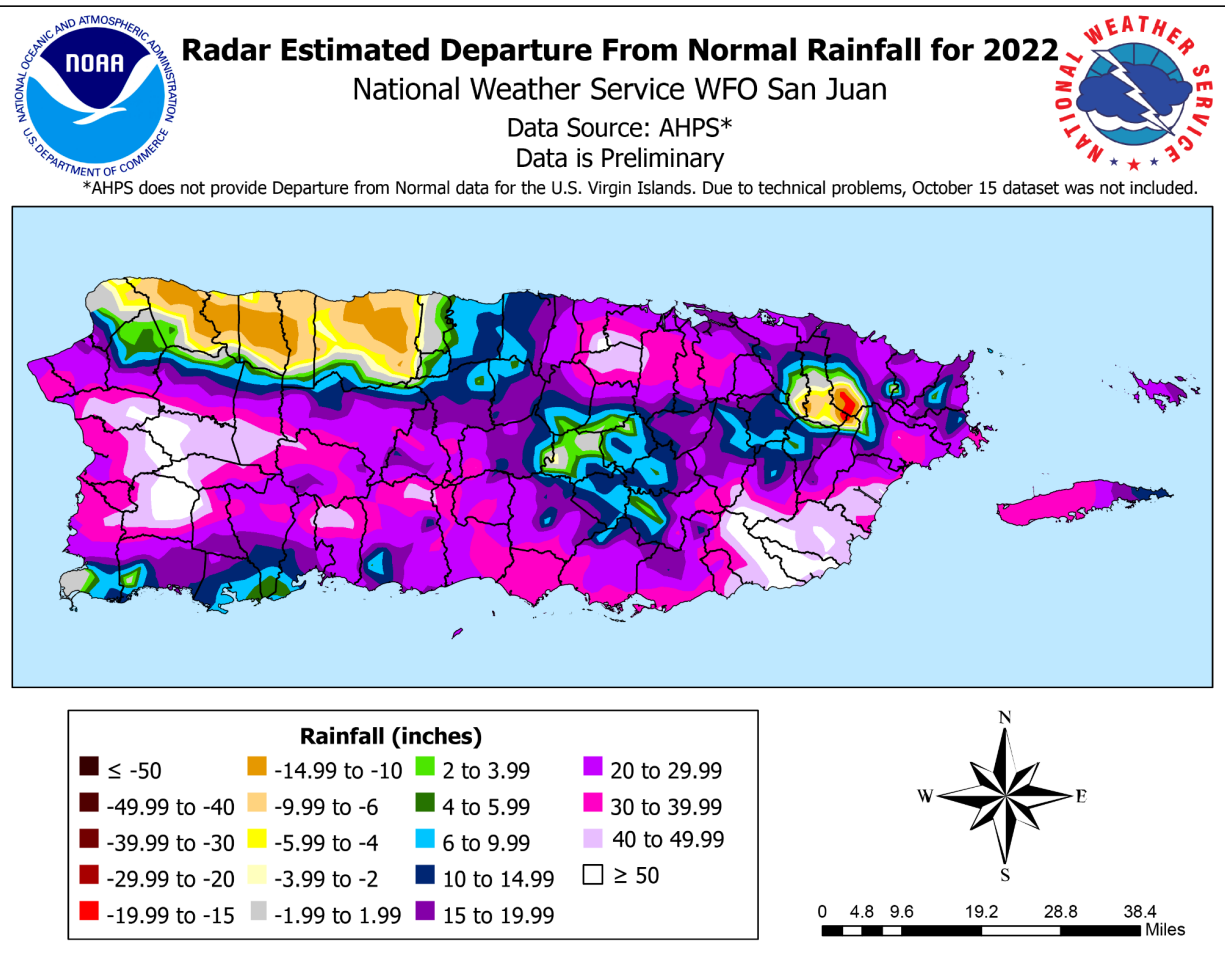


Fig. 14. Radar Estimated Departure from Normal Rainfall for 2022. Most of Puerto ended with well above normal rainfalls. However, the northwest, an area that was not as affected by big events of 2022, such as Fiona or the other events in October and November, that affected the rest of the area ended below normal. El Yunque area also ended below normal, even though it did receive over 150 inches of rain, normal values for this location are around 170 inches.